JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2003, **36,** 439–448 NUMBER 4 (WINTER 2003)

PERSISTENCE OF STEREOTYPIC BEHAVIOR: EXAMINING THE EFFECTS OF EXTERNAL REINFORCERS

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Basic research has shown that behavioral persistence is often positively related to rate of reinforcement. This relation, expressed in the metaphor of behavioral momentum, has potentially important implications for clinical application. The current study examined one prediction of the momentum metaphor for automatically reinforced behavior. Participants were 3 children who had been diagnosed with an autism spectrum disorder and who engaged in stereotypic behavior maintained by automatic reinforcement. Results suggested that stereotypic behavior was more resistant to disruption following periods of access to preferred stimuli delivered on a variable-time schedule than following periods without access to preferred stimuli. The implications of these findings for the treatment of automatically reinforced behavior are discussed.

DESCRIPTORS: behavioral momentum, automatic reinforcement, resistance to change, stereotypy, autism

A substantial number of basic studies have documented a positive relation between the reinforcer rate for a discriminated operant and the behavior's resistance to change (see Nevin & Grace, 2000, for a review). For example, if obtained reinforcer rates are substantially different in two components of a multiple schedule, resistance to disrupters such as satiation and extinction is most often greater in the richer component (e.g., Nevin, Tota, Torquato, & Shull, 1990). This relation has been shown when additional reinforcers were delivered independently of responding in one component (Nevin et al.), and when the additional reinforcers were qualitatively different from those that were delivered contingently upon responses (Grimes & Shull, 2001). Resistance to change and response rate are brought together in the metaphor of behavioral momentum, with the rate of responding analogous to velocity and the analogue of behavioral mass related to reinforcer rate (Nevin, 1992; Nevin & Grace, 2000).

Research examining reinforcer-rate effects

We thank Vicki Bousquet, Ellen Bender, and Keri Rutherford for their assistance in conducting this study.

This research was supported in part by Grant HD33802 from the National Institute of Child Health and Human Development (NICHD). The contents of this paper are solely the responsibility of the authors and do not necessarily represent official views of NICHD.

Portions of this manuscript were presented at the 28th annual meeting of the Association for Behavior Analysis, Toronto, Ontario, Canada, May, 2002.

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on relative resistance to change has been extended to human behavior in a small but growing number of studies (Cohen, 1996; Dube & McIlvane, 2001; Dube, McIlvane, Mazzitelli, & McNamara, 2003; Mace et al., 1990). Research inspired by behavioral momentum theory has garnered the attention of applied behavior analysts because of its implications for decreasing the resistance to change of inappropriate behavior and for increasing the persistence of appropriate behavior (e.g., Mace, 2000; Plaud & Gaither, 1996; Strand, 2000).

Momentum theory predicts that reinforcers added to a situation should make behavior occurring in that context more likely to persist regardless of whether response rates increase or decrease. One potentially important implication is that certain interventions may decrease the rates of undesirable behavior yet contribute to behavioral persistence. For example, Mace (2000) described the potential difficulty of reinforcing appropriate behavior in the context in which undesirable behavior is maintained. He and his colleagues found that differential reinforcement of alternative behavior (DRA) decreased the rate of undesirable behavior but strengthened the subsequent persistence of that behavior (data presented in Nevin, 1997). In terms of the momentum metaphor, an increase in the overall rate of reinforcement in the presence of the controlling stimuli for problem behavior may decrease the rate (velocity) but increase the behavioral mass of the response class.

Results of research conducted by Iwata and colleagues suggest that approximately one quarter of all self-injurious behavior is maintained by the sensory consequences produced by the behavior (Iwata et al., 1994). The presumed automatic reinforcement of a response, however, is only one possible explanation for the persistence of behavior across environments. Vollmer (1994) discussed alternative possibilities that such behavior could be respondent (Romanczyk, Lockshin, & O'Conner, 1992) or adjunctive (Emerson & Howard, 1992) in nature. One way to confirm that automatically reinforced behavior is operant would be to demonstrate that it is functionally similar to other operant behavior.

White and Cameron (2000) discussed how momentum theory might apply to intrinsically reinforced behavior. There is a long-held assumption that providing extrinsic reinforcers for intrinsically maintained behavior decreases the baseline level of occurrence of that behavior (e.g., Deci, Koestner, & Ryan, 1999). White and Cameron contested this assertion, pointed to conflicting evidence (see also Reitman, 1998, for a summary), and proposed that adding extrinsic reinforcers into a context in which intrinsically reinforced behavior occurs may increase persistence. White and Cameron also suggested that this prediction of momentum theory could be tested by exposing behavior to extinction (or in this case disruption) after responding has and has not been exposed to a condition in which extrinsic reinforcers were overlaid upon the prevailing contingencies.

It is well documented that reinforcers, contingently or noncontingently delivered, can decrease the frequency of undesirable behavior apparently maintained by automatic reinforcement (e.g., Cowdery, Iwata, & Pace, 1990; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Piazza, Roane, Keeney, Boney, & Abt, 2002; Steege, Wacker, Berg, Cigrand, & Cooper, 1989). External reinforcers may compete with automatic reinforcers and decrease response rates (Fisher & Mazur, 1997; McDowell, 1982) but have little enduring effect on the problem behavior's persistence. Then again, external reinforcers may supplement automatic ones and thus increase the persistence of the behavior in question, as predicted by behavioral momentum theory. The purpose of the current

study was to examine this possibility with stereotypic behavior that was apparently maintained by automatic reinforcement.

METHOD

Participants and Setting

Participants were 3 boys who had been diagnosed with an autism spectrum disorder by a professional not affiliated with the New England Center for Children. They had been referred by their clinical and educational service providers as exhibiting stereotypic behavior that interfered with participation in educational activities or occurred at unacceptable levels outside class times. An analogue functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) was conducted with each student. Results for all participants indicated that their stereotypic behavior was apparently maintained by automatic reinforcement (data are available from the first author).

Cal was a 4-year-old boy who had been diagnosed with pervasive developmental disorder—not otherwise specified (PDD-NOS); he received educational and clinical services in a preschool setting and lived with his parents. He engaged in vocal stereotypy. Cal communicated verbally and initiated social interaction; however, the majority of his spontaneous language consisted of scripted phrases acquired through directed instruction. Edy was an 8-year-old boy who had been diagnosed with PDD-NOS; he received educational and clinical services in a day-school setting and lived with his parents. He exhibited stereotypic hand movements. Edy had limited leisure skills but would rarely engage in them independently. Lou was a 9-year-old boy who had been diagnosed with PDD–autism and who was a residential student at the time of the study. Lou rarely engaged in leisure activities without also engaging in stereotypic hand movements. Object manipulation was typically associated with flapping of the materials, and stereotypic behavior occurred most consistently when items to flap were available.

All sessions were conducted in a room (1.5 m by 3 m) equipped with wide-angle video camera, microphone, video recording equipment, materials necessary to conduct the conditions, and an appropriately sized table with two chairs.

Response Measurement and Interobserver Agreement

Vocal stereotypy (Cal) was defined as acontextual vocalizations such as repetitive grunts, squeals, and phrases unrelated to the present situation. Examples include "ee, ee, ee, ee" and maniacal laughter in the absence of a humorous event. *Hand stereotypy* (Edy and Lou) was defined as repetitive tapping, wringing, or flapping of the hands. All sessions were videotaped and scored by trained observers. During the initial activity assessment, data on stereotypic behavior and engagement were collected using 10-s momentary time sampling. Occurrence agreement scores were calculated for a minimum of 33% of sessions (range, 33% to 100%) across participants, and mean agreement scores exceeded 87% for stereotypy and 90% for engagement. During the test for behavioral persistence, data on stereotypic behavior were collected using continuous duration recording. The total number of seconds of stereotypy in each session was divided by the total number of seconds in the session (300 s) and multiplied by 100% to calculate the proportion of the session in which stereotypic behavior occurred. Exact agreement data were calculated for a minimum of 50% of sessions for each participant (range, 50% to 100%), and agreement exceeded 92% across conditions and participants. Agreement for Cal's vocal stereotypy was 92% (range, 88% to 95%), agreement for Edy's hand stereotypy was 94% (range, 90% to 98%), and

agreement for Lou's flapping was 97% (range, 94% to 99%).

Competing-Items Assessment

Prior to the study, an activity assessment similar to that described by Piazza et al. (1998) was conducted with each participant to identify items that were associated with low levels of stereotypic behavior. The participant had continuous access to an item during 5-min (for food items) or 8-min periods. Duration of engagement with the item and the duration of stereotypy were measured. Items evaluated in this assessment had been identified as highly preferred via a preference assessment similar to that described by Fisher et al. (1992). A few additional activities (e.g., watching videos, listening to music, bouncing on a large ball) were also evaluated. The purpose of these assessments was to identify activities that would compete with the presumed automatic reinforcer for stereotypy and thus would function to disrupt stereotypic behavior during a test for behavioral persistence or momentum.

For each participant, two items were selected for use during the analysis of behavioral persistence (described below). These items were correlated with high levels of engagement (70% of intervals or greater) and low levels of stereotypy (less than 25% of intervals) when continuously available during the activity assessments. These items were a book that involved a matching-to-sample task and a video for Cal, a slinky and a video for Edy, and popcorn and a large ball for Lou. The videos (Cal and Edy) and large ball (Lou) served as the disrupters during the test condition (see below) and were chosen because they were correlated with the most consistent levels of engagement. The matching-to-sample task (Cal), the slinky (Edy), and popcorn (Lou) were used as the stimuli delivered during the variable-time (VT) exposure condition (see below).

Evaluation of Behavioral Persistence

The purpose of this evaluation was to determine whether response-independent exposure to one preferred stimulus (from the competing-items assessment) would increase behavioral persistence and thus decrease the effectiveness of a second preferred stimulus (a different one from the competing-items assessment) to function as a disrupter for stereotypy. Levels of stereotypic behavior were compared during three conditions: baseline (no preferred stimulus available), VT exposure (first preferred stimulus available), and test (second preferred stimulus available). These three conditions (defined in more detail below) were conducted in two sequences: behavioral momentum (B-MO) and control. In the B-MO sequence, four sessions were conducted in the following order: baseline, VT exposure, test, baseline. In the control sequence, the four sessions were conducted as follows: baseline, baseline, test, and baseline. Thus, baseline sessions preceded one half of the test sessions, and VT exposure sessions preceded the other half of the test sessions.

Only one sequence was conducted on any single day, and the two sequences were evaluated three times for Cal and Edy (for a total of 24 sessions) and four times for Lou (for a total of 32 sessions). All sessions lasted 5 min, except as noted below.

During baseline, a therapist was present but did not attend to the participant. No play materials were available for Cal or Edy. Certain play materials that set the occasion for stereotypic behavior (flapping) were present in all of Lou's sessions. The VT exposure condition was identical to baseline except that three 30-s periods of access to high-preference items (matching book for Cal, slinky for Edy, and popcorn for Lou) were provided. The three access periods were initiated according to a VT schedule, with delivery times determined quasirandomly.

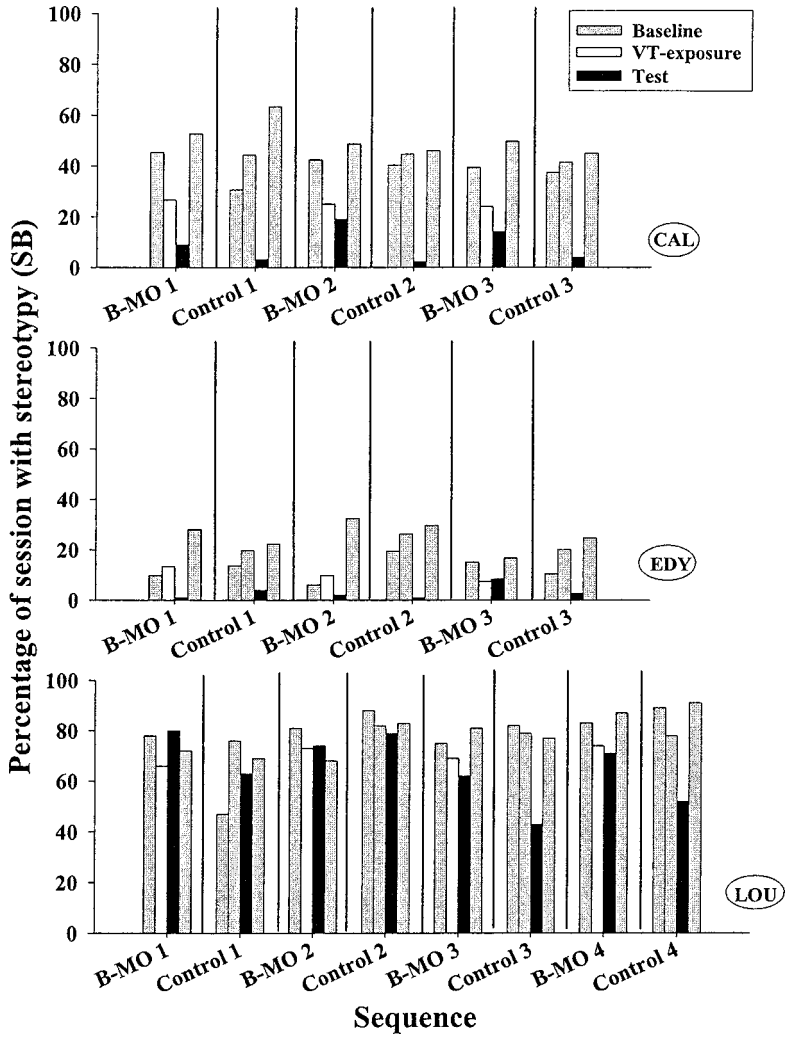

Figure 1. Percentages of session with stereotypic behavior for Cal (top panel), Edy (middle panel), and Lou (bottom panel).

Data on stereotypic behavior that occurred during the access periods were not included in the results. That is, the access periods were subtracted from the total session time so that each session consisted of 5 min in which high-preference items were absent. The duration of the second baseline session in the control sequence was yoked to the duration of the preceding VT exposure session in the B-MO sequence, and time intervals that corresponded to the access periods in the B-MO sequence were omitted from the data analyses for the control condition. The test condition included continuous access to items likely to disrupt stereotypic behavior and provided the primary dependent measure for this study. Procedures for the test condition in both sequences were identical to those for baseline except that an activity (video for Cal and Edy and a large ball for Lou) was available continuously.

RESULTS

Figure 1 shows the percentage of session with stereotypic behavior during all experi-

mental conditions for each participant. Each phase shows the sequence of four sessions in either the B-MO or control sequences. The first and fourth bars in each phase show stereotypic behavior in the first and fourth baseline sessions, respectively, during each sequence. The second bar shows the level of stereotypic behavior in the second session (VT exposure in the B-MO sequence; baseline in the control sequence). The third bar in each sequence shows the level of stereotypic behavior during test sessions in which a competing activity was continuously available. The data show that levels of stereotypic behavior were often, but not always, lower in VT exposure sessions than in baseline sessions. Furthermore, levels of stereotypic behavior were frequently higher (i.e., more persistent) during test sessions in the B-MO sequence than during test sessions in the control sequence.

To evaluate relative changes in behavior, levels of stereotypic behavior in the VT exposure and test sessions were expressed as a proportion of mean levels of stereotypy during baseline sessions within the same conditions. Proportional measures were calculated by dividing the percentage of session with stereotypy in the second (Figure 2, left) or third (Figure 2, right) session by the mean percentage for the first and fourth sessions. One experimental question concerned the effects on stereotypic behavior of limited access to a preferred stimulus. Relevant data are shown in the left column of Figure 2 (stereotypic behavior during the second session as a proportion of baseline). The data shown by the white bars were obtained during the VT exposure sessions of the B-MO sequence, and the gray bars show stereotypy during the baseline sessions of the control sequence with no item access. Stereotypic behavior was reduced during the VT exposure sessions by approximately half for Cal and Edy, but there was little or no reduction for Lou. Thus, for 2 of the 3 participants, the effects of response-independent activity access were similar when access to the preferred stimuli was continuous (during the competing-items assessments) and when access was restricted to three brief periods (during the VT exposure sessions). It should also be noted that levels of stereotypy during the second baseline sessions of the control sequence confirm that there was little change in stereotypic behavior during sessions in which the preferred stimuli were not present.

The white and gray bars (right column of Figure 2) show the level of stereotypic behavior in the test sessions of the B-MO and control conditions, respectively, as a proportion of the levels of stereotypic behavior during baseline sessions. Stereotypy was more persistent following access to preferred stimuli in eight of ten comparisons, including all three comparisons for Cal, two of three for Edy, and three of four for Lou. In Lou's first two comparisons, the proportion of session with stereotypic behavior relative to baseline was near 1.0, indicating that the ball was not an effective disrupter in these sessions. With these comparisons omitted, the results show greater persistence of stereotypic behavior following access to preferred stimuli in six of seven comparisons.

DISCUSSION

The primary finding was that stereotypy was more resistant to change during test sessions in the B-MO sequence than in the control sequence. This result is consistent with the prediction that added reinforcers can increase the persistence of behavior, and it extends the application of the momentum metaphor to a problem of clinical significance. In addition, intermittent access to preferred stimuli decreased levels of stereotypy for Cal and Edy but not for Lou. Continuous access to a different preferred activity during test sessions significantly disrupted stereotypy for Cal and Edy and slightly

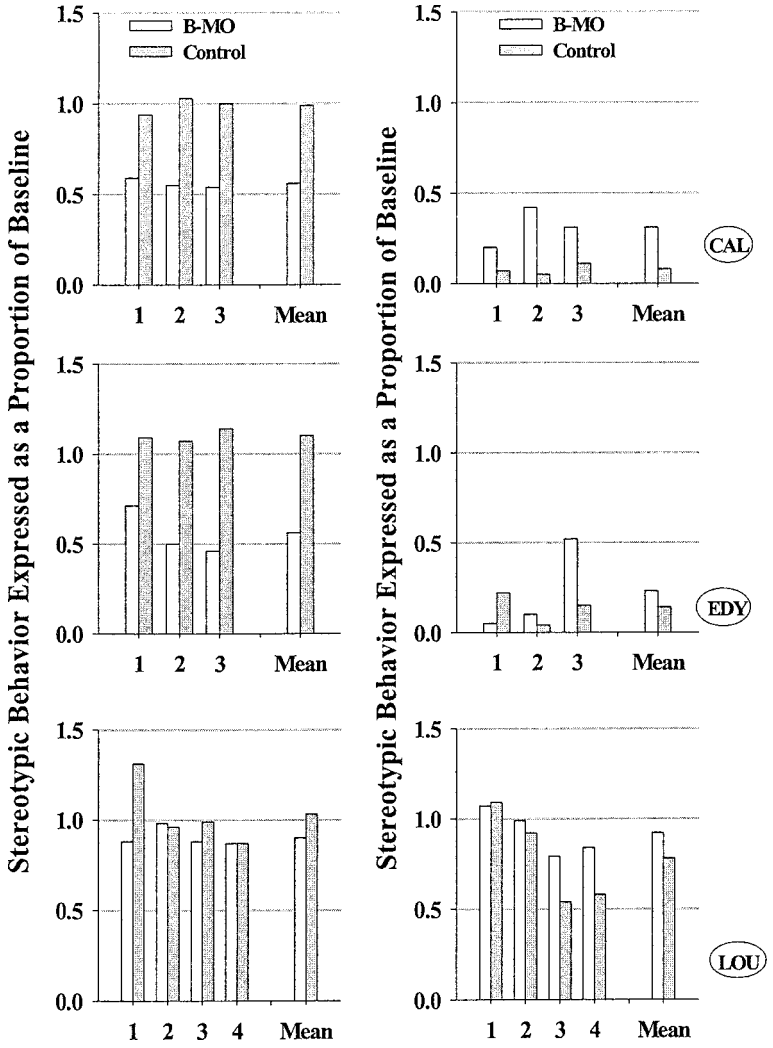

Figure 2. The level of stereotypic behavior during the second session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons (left). The level of stereotypic behavior during the test session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons (right). The mean for all comparisons is shown in the rightmost portion of each plot.

disrupted it for Lou. Because the behavior of these participants was sensitive to external reinforcement contingencies, the results are also consistent with an interpretation that these instances of automatically reinforced stereotypy could be appropriately classified as operant behavior.

One limitation of the study was the relatively brief number and duration of sessions. Issues for further research include whether differential persistence with and without added reinforcers would decrease, continue, or perhaps even increase over a longer course of repeated testing. The possibility of an increase is suggested by Lou's results in which differential persistence appeared to develop over the course of four test sessions. Another concern is the magnitude of the differential persistence effect. For Cal and Edy, whose stereotypic behavior occurred during about

50% of each baseline session and was relatively amenable to disruption (test–baseline ratios .5 or less in Figure 2, right column), mean responding in the B-MO sequences was approximately 400% and 160%, respectively, of that in the control test sessions. For Lou, whose stereotypic behavior occurred at high levels and was not readily disrupted (at least by the procedure used in this study), the difference in behavioral persistence was much smaller, with responding during the test condition of the B-MO sequence approximately 118% of that in the test condition of the control sequence. This variability in the results suggests base-rate effects as a topic for further research. Furthermore, different outcomes may have been obtained for Lou if a more effective disrupter had been used during the test sessions.

An important implication of the findings concerns the long-term effects of response-independent reinforcers (i.e., noncontingent reinforcement) on problem behavior. Given that extrinsic reinforcers are explicitly arranged and often delivered quite frequently (at least in the initial phases of treatment) in the context in which problem behavior occurs, response-independent reinforcers could increase the persistence of problem behavior, even though the short-term effect of response-independent reinforcers is often a reduction in the rate or duration of problem behavior. Careful consideration and close monitoring of response-independent schedules of reinforcement as interventions for undesirable behavior seems warranted. Further investigation into this topic could determine whether the immediate effects will persist over an extended period of treatment.

Extrinsic reinforcers also may be arranged for desirable behavior (e.g., mands, social initiations) to increase the likelihood that such behavior will be emitted. However, if external reinforcers are added into situations with high rates of undesirable behavior, the external reinforcers may also result in increased persistence of the undesirable behavior. For example, Mace (2000) noted that DRA procedures add reinforcers into the context in which problem behavior is ongoing. Mace suggested that training appropriate behavior outside the context of the problem behavior might help to avoid or limit any enhancement of the problem behavior's persistence as a result of the added reinforcers.

In summary, the present study (a) offers evidence of the applicability of Nevin's (1992) metaphor of behavioral momentum to clinically relevant problem behavior and (b) contributes to the body of evidence showing that behavioral momentum describes a general behavioral principle. Results were consistent with the hypothesis that extrinsic reinforcers overlaid upon an intrinsically reinforced operant can enhance behavioral persistence, although unanswered questions about the magnitude and robustness of this finding indicate the need for more research. The present study does, however, underscore the importance of Nevin's conceptualization of resistance to change as an index of response strength. Given that resistance to change is one of the frequent challenges faced by applied behavior analysts, an increased understanding of the relevant controlling variables in clinical contexts will be valuable for clinicians.

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Received December 11, 2002
Final acceptance August 12, 2003
Action Editor, Dorothea Lerman

STUDY QUESTIONS

1. According to behavioral momentum theory, what is the general effect of reinforcement on behavior?

2. What was the purpose of the competing stimulus assessment, and why were two items used in the evaluation of behavioral persistence?

3. Describe the baseline, VT exposure, and test conditions during the evaluation of behavioral persistence. Why were test conditions sometimes preceded by the baseline condition and sometimes preceded by the VT exposure condition?

4. What was the purpose of the second baseline session?

5. Why were levels of stereotypy observed in the VT exposure and test conditions expressed as proportions of baseline levels? How were these proportional measures calculated, and what did the results suggest?

6. Summarize the results of Figure 1 with respect to responding observed (a) during VT exposure conditions relative to baseline, (b) during B-MO and control test conditions relative to the preceding condition (VT exposure or baseline), and (c) across B-MO and control test conditions.

7. How were the results of this study consistent with the predictions of behavioral momentum theory? What is a potential negative implication of these results for the use of reinforcement-based procedures, and how might it be prevented?

8. Provide an alternative explanation for the present results based on the influence of establishing operations on stereotypy.

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